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Nakayama

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(54) **IMAGE FORMING APPARATUS AND METHOD IN WHICH A DEVELOPER CARRYING MEMBER IS ROTATED FOR A PREDETERMINED TIME DURING A STARTUP OR REMOVAL OPERATION**

(71) Applicant: **Masayoshi Nakayama**, Ibaraki (JP)

(72) Inventor: **Masayoshi Nakayama**, Ibaraki (JP)

(73) Assignee: **Ricoh Company, Ltd.**, Tokyo (JP)

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G03G 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/5008*** (2013.01); ***G03G 15/0806*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/06; G03G 15/5012; G03G 15/5008; G03G 15/0806
See application file for complete search history.

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Primary Examiner — Billy Lactaoen
Assistant Examiner — Arlene Heredia Ocasio
(74) *Attorney, Agent, or Firm* — IPUSA, PLLC

(57) **ABSTRACT**

An image forming apparatus includes a latent image bearer that carries a latent image and a developer carrier including a developer carrying member that carries a developer on a surface thereof. The developer carrier conveys the developer to a developing position opposite to the latent image bearer by moving the developer carrying member so as to develop the latent image carried by the latent image bearer. In a startup operation after a stop operation performed during a developing operation by the developer carrier, the developer carrying member is rotated for a predetermined time while the latent image bearer is set in a stopped state before starting a rotation.

20 Claims, 11 Drawing Sheets

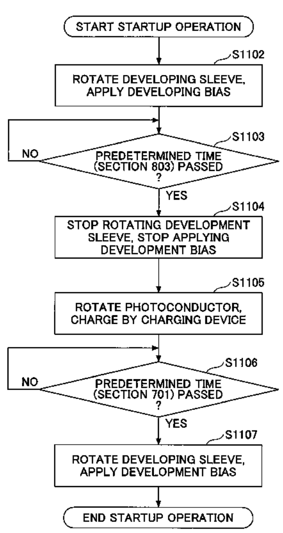

FIG.1

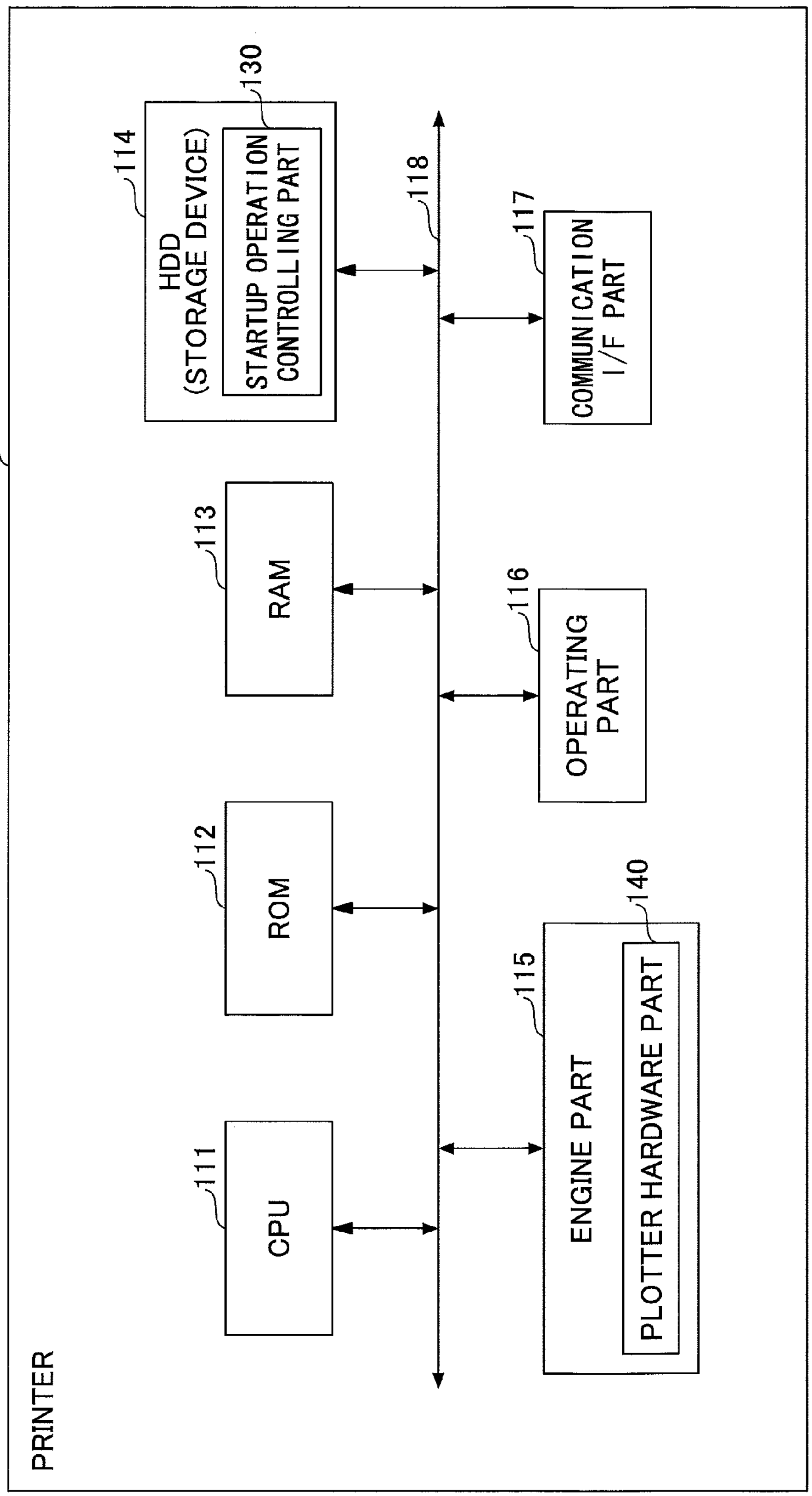
PRINTER
100
CPU
111
ROM
112
RAM
113
HDD
(STORAGE DEVICE)
114
STARTUP OPERATION CONTROLLING PART
130
118
ENGINE PART
115
PLOTTER HARDWARE PART
140
OPERATING PART
116
COMMUNICATION I/F PART
117

FIG.2

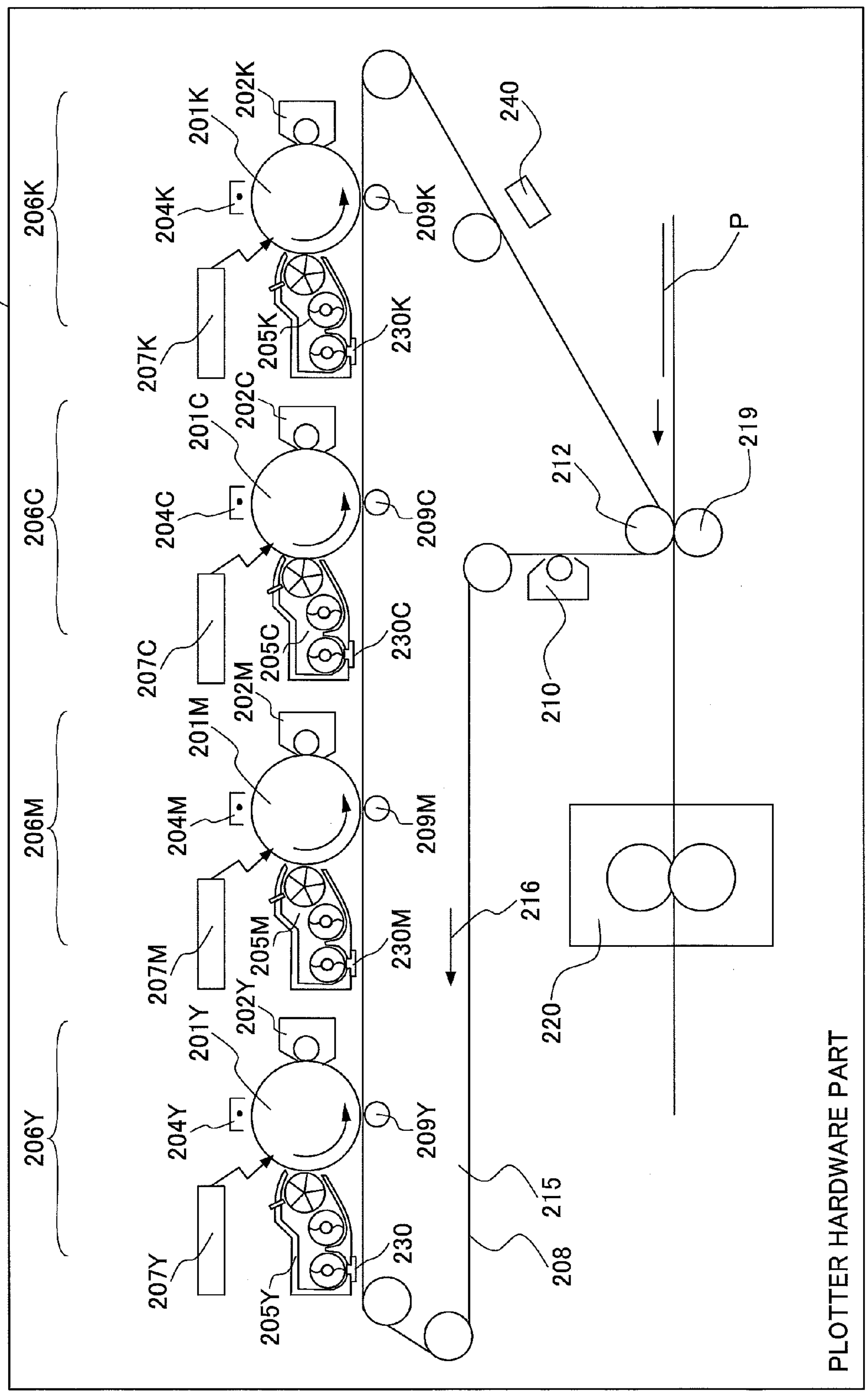
140
206K
206C
206M
206Y
201K
202K
204K
205K
207K
209K
230K
201C
202C
204C
205C
207C
209C
230C
201M
202M
204M
205M
207M
209M
230M
201Y
202Y
204Y
205Y
207Y
209Y
230
208
210
212
215
216
219
220
240
P
PLOTTER HARDWARE PART

FIG.3

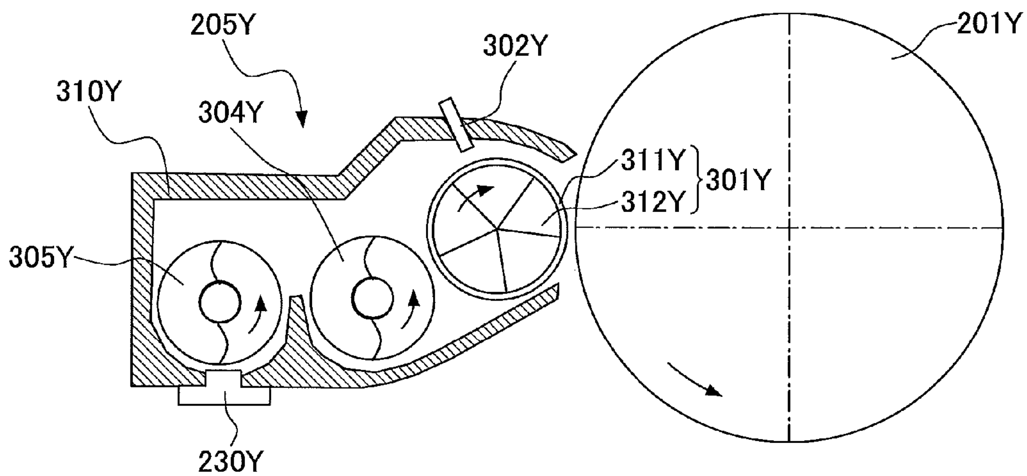

FIG.4A

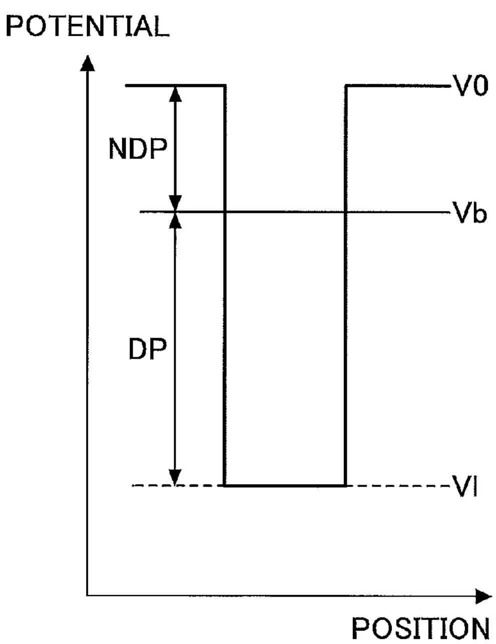

FIG.4B

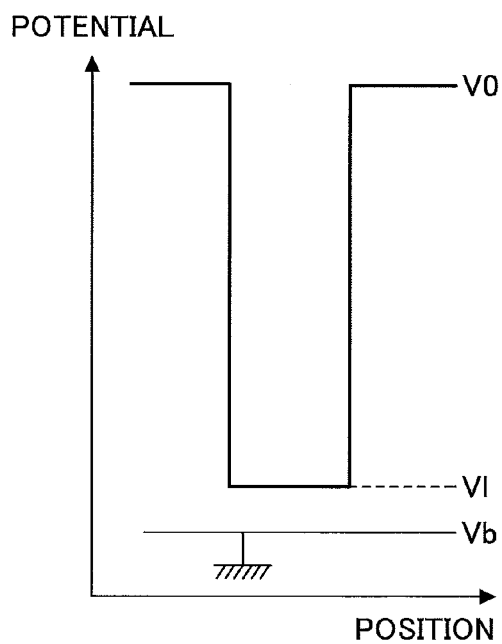

FIG.5

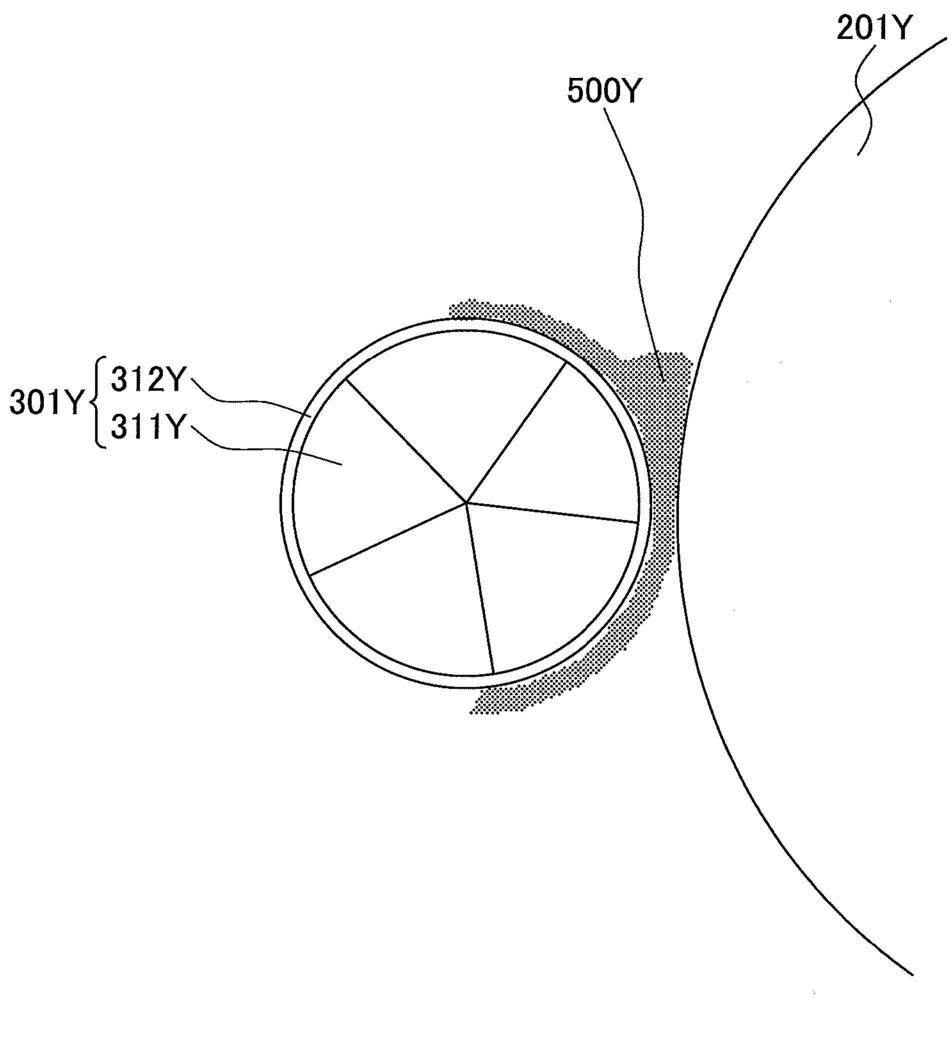

FIG.6

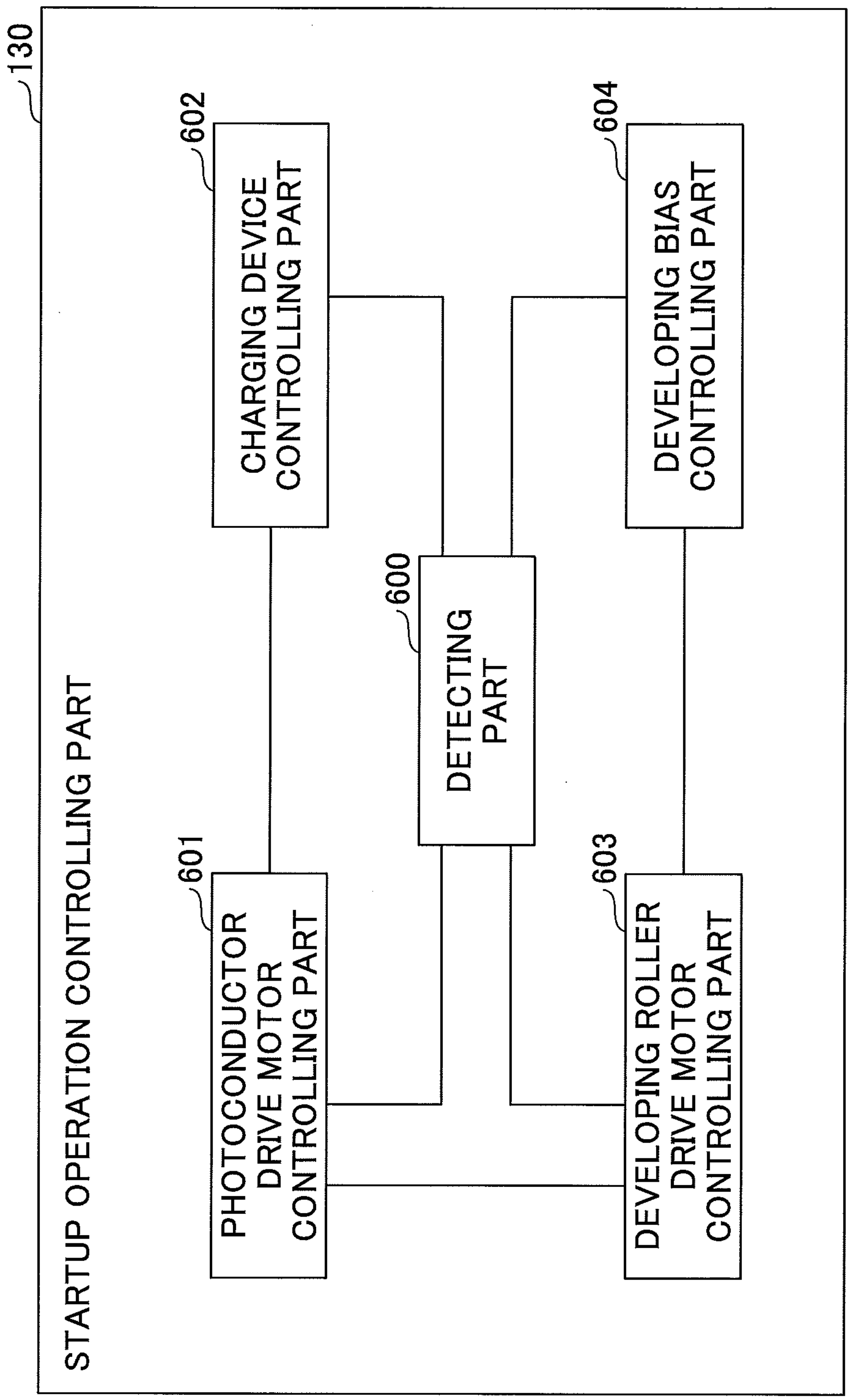
130
STARTUP OPERATION CONTROLLING PART
602
CHARGING DEVICE CONTROLLING PART
604
DEVELOPING BIAS CONTROLLING PART
600
DETECTING PART
601
PHOTOCONDUCTOR DRIVE MOTOR CONTROLLING PART
603
DEVELOPING ROLLER DRIVE MOTOR CONTROLLING PART

FIG.7

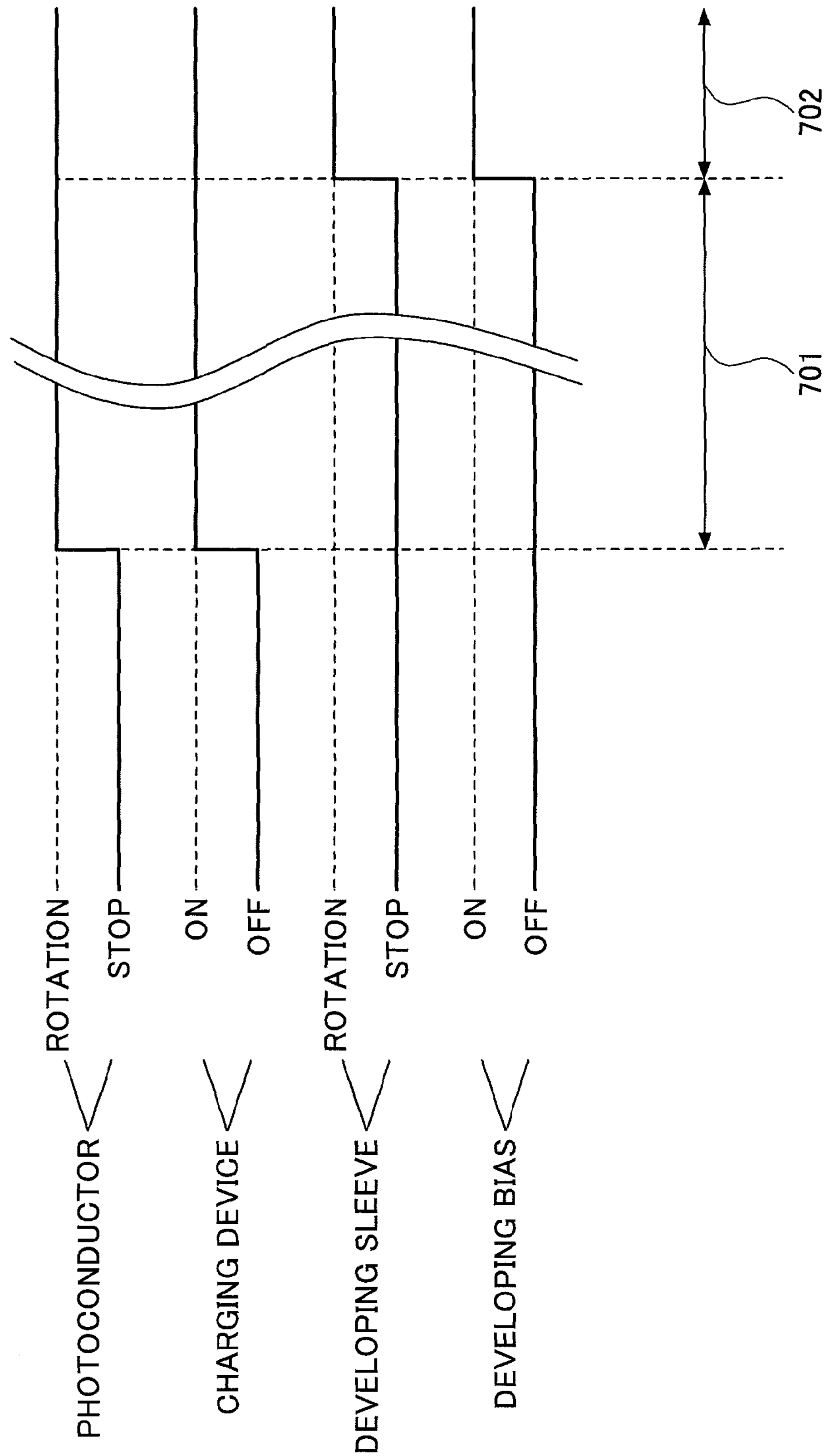
PHOTOCONDUCTOR
ROTATION
STOP
CHARGING DEVICE
ON
OFF
DEVELOPING SLEEVE
ROTATION
STOP
DEVELOPING BIAS
ON
OFF
701
702

FIG.8

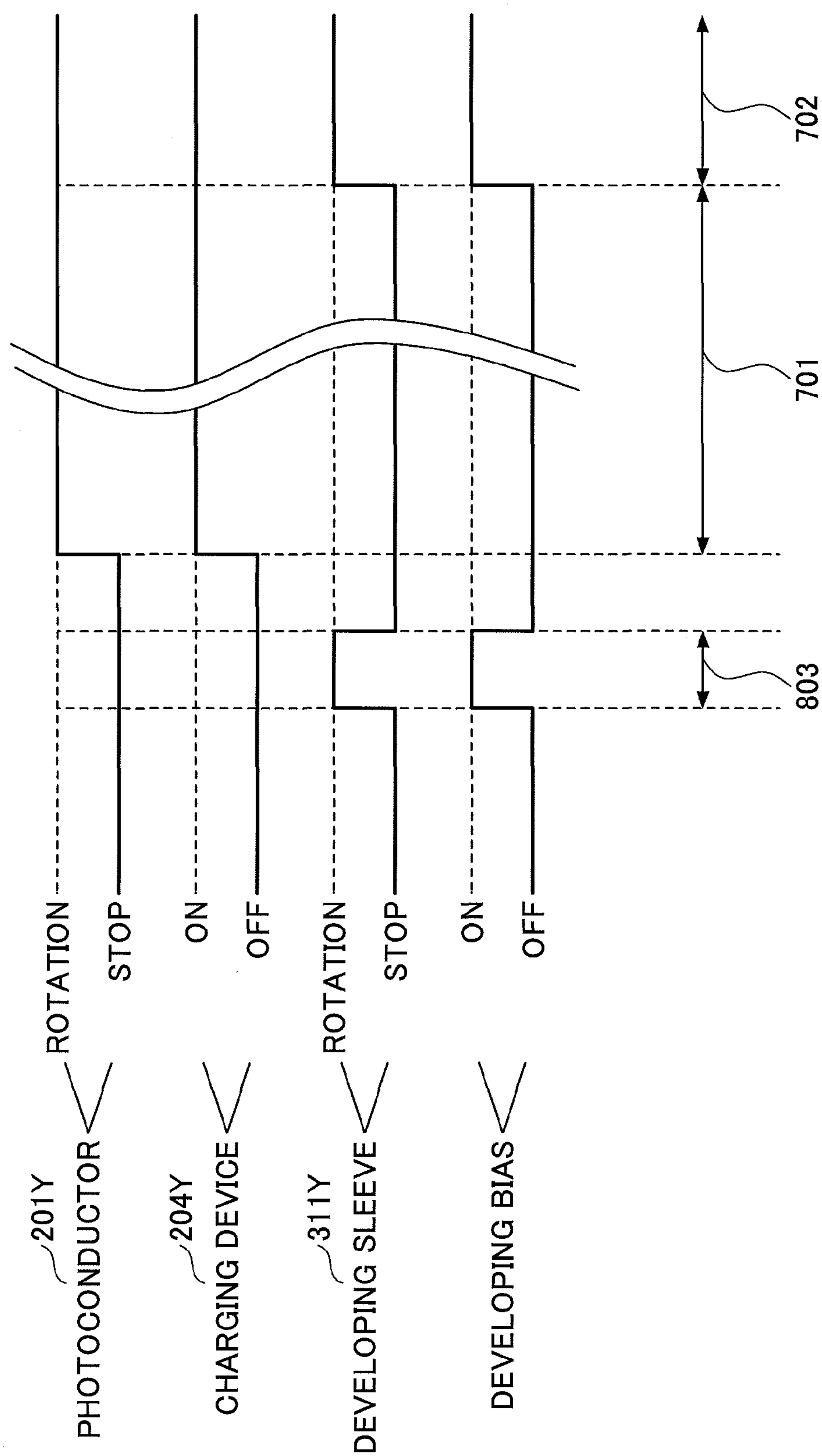
201Y
PHOTOCONDUCTOR
ROTATION
STOP
204Y
CHARGING DEVICE
ON
OFF
311Y
DEVELOPING SLEEVE
ROTATION
STOP
DEVELOPING BIAS
ON
OFF
702
701
803

FIG.9

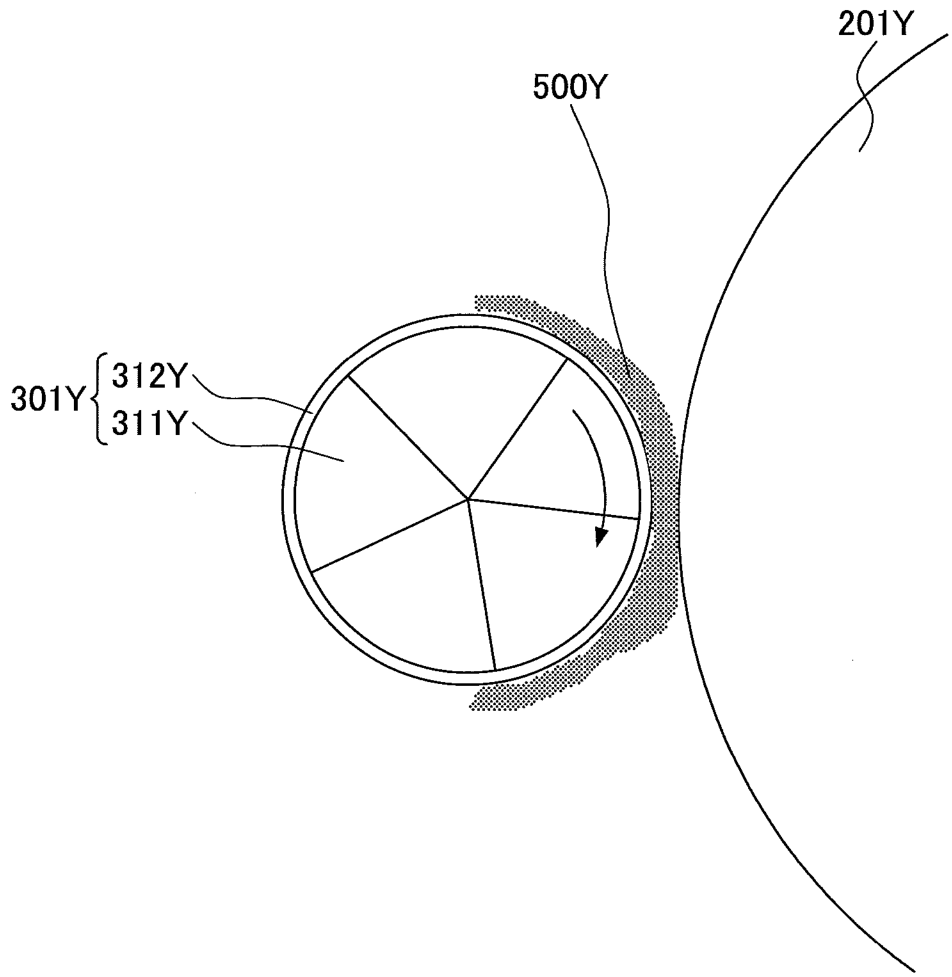

FIG.10A FIG.10B

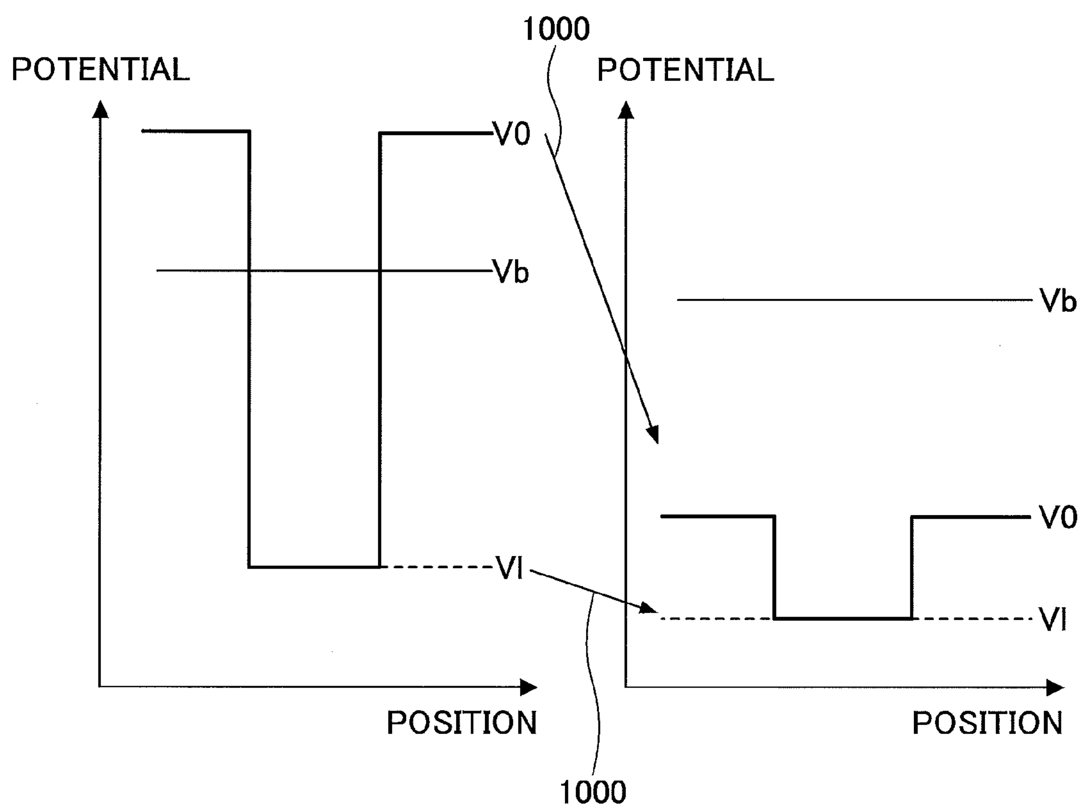

FIG.11

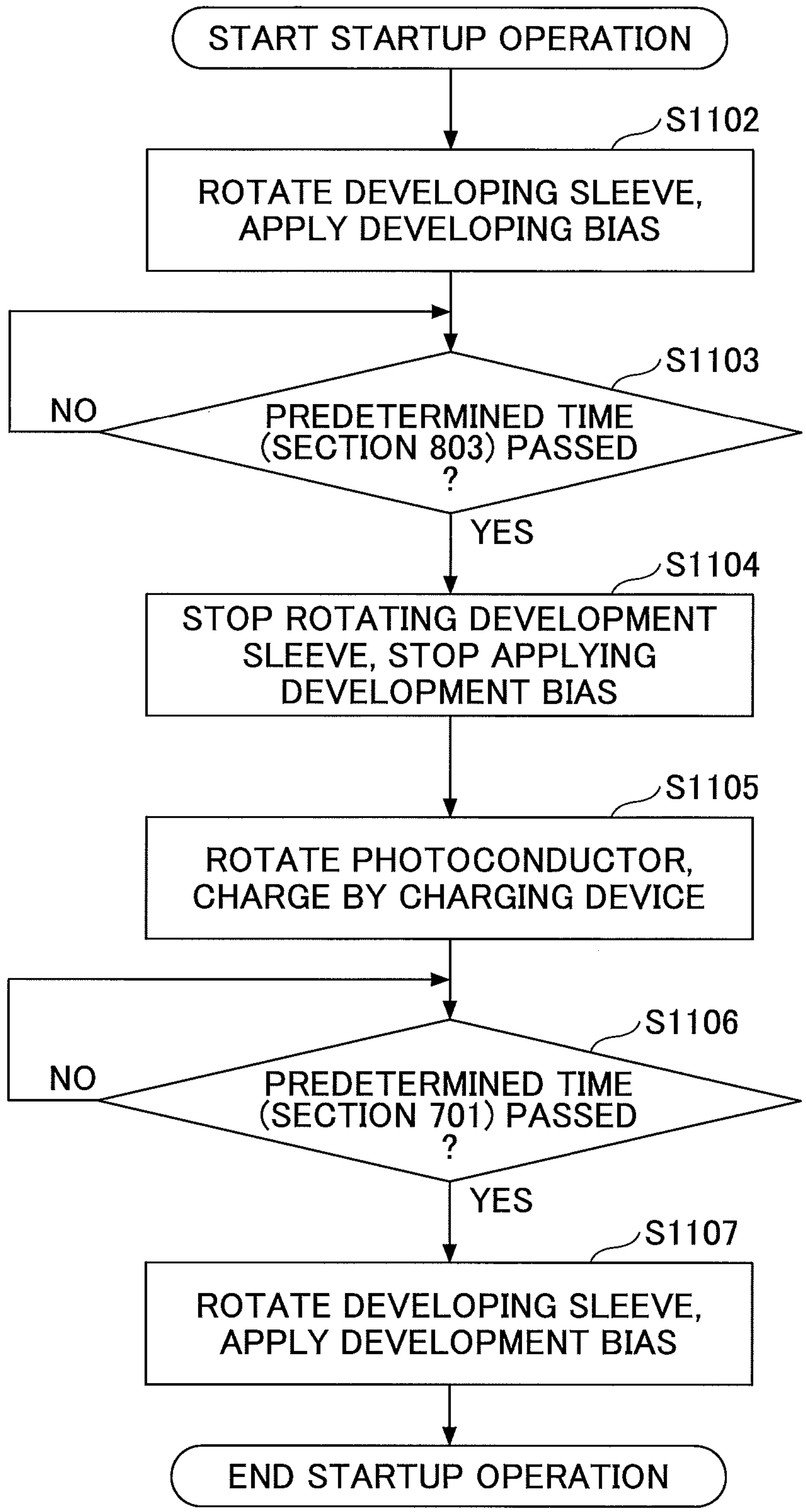
START STARTUP OPERATION
S1102
ROTATE DEVELOPING SLEEVE, APPLY DEVELOPING BIAS
S1103
PREDETERMINED TIME (SECTION 803) PASSED ?
NO
YES
S1104
STOP ROTATING DEVELOPMENT SLEEVE, STOP APPLYING DEVELOPMENT BIAS
S1105
ROTATE PHOTOCONDUCTOR, CHARGE BY CHARGING DEVICE
S1106
PREDETERMINED TIME (SECTION 701) PASSED ?
NO
YES
S1107
ROTATE DEVELOPING SLEEVE, APPLY DEVELOPMENT BIAS
END STARTUP OPERATION

FIG.12

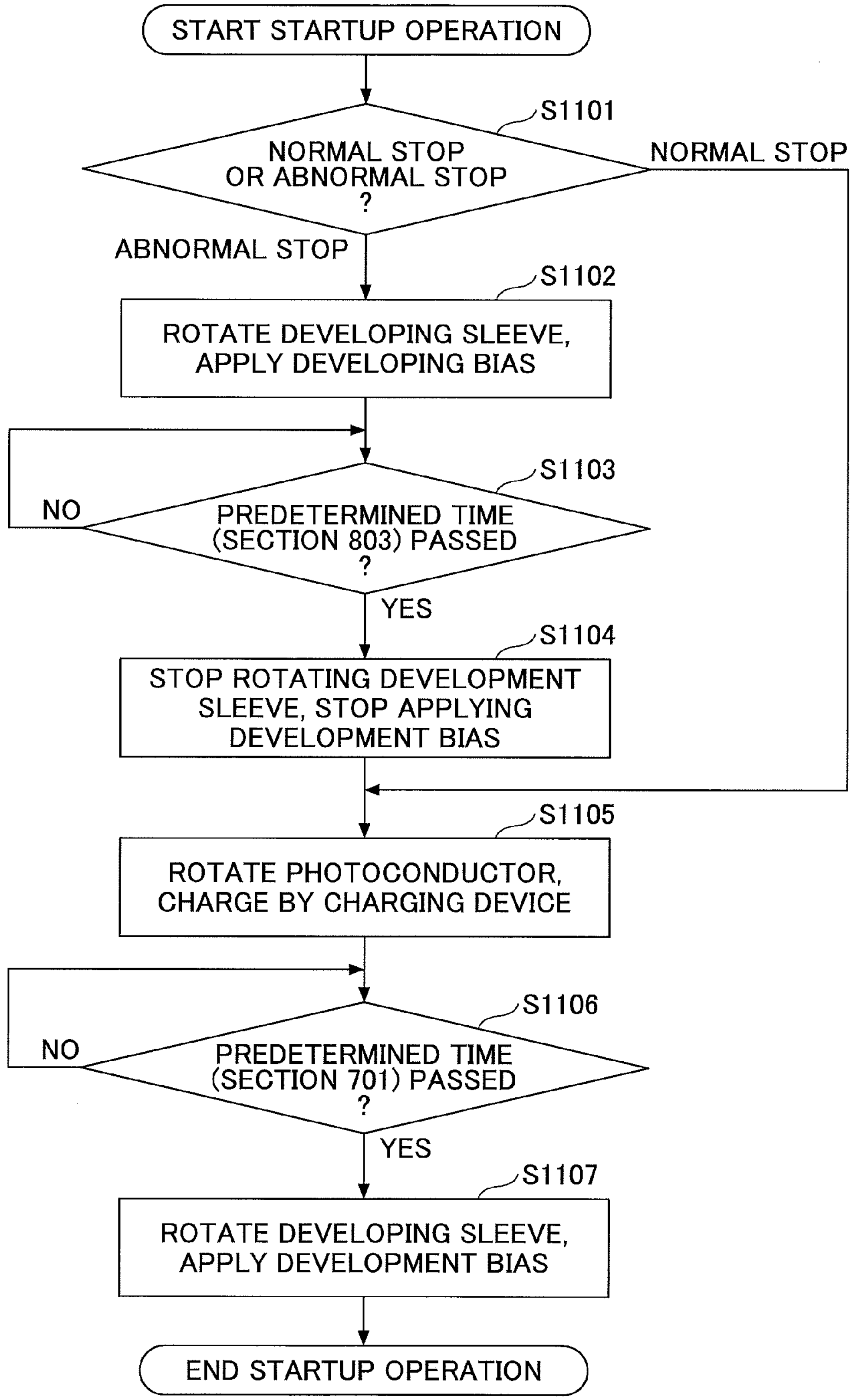
START STARTUP OPERATION
S1101
NORMAL STOP OR ABNORMAL STOP ?
NORMAL STOP
ABNORMAL STOP
S1102
ROTATE DEVELOPING SLEEVE, APPLY DEVELOPING BIAS
S1103
NO
PREDETERMINED TIME (SECTION 803) PASSED ?
YES
S1104
STOP ROTATING DEVELOPMENT SLEEVE, STOP APPLYING DEVELOPMENT BIAS
S1105
ROTATE PHOTOCONDUCTOR, CHARGE BY CHARGING DEVICE
S1106
NO
PREDETERMINED TIME (SECTION 701) PASSED ?
YES
S1107
ROTATE DEVELOPING SLEEVE, APPLY DEVELOPMENT BIAS
END STARTUP OPERATION

IMAGE FORMING APPARATUS AND METHOD IN WHICH A DEVELOPER CARRYING MEMBER IS ROTATED FOR A PREDETERMINED TIME DURING A STARTUP OR REMOVAL OPERATION

CROSS-REFERENCE TO RELATED APPLICATION

The present application is based upon and claims the benefit of priority of Japanese Patent Application No. 2014-005705, filed on Jan. 16, 2014, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to an image forming apparatus such as a copy machine, a printer, a facsimile, a multifunction peripheral of the aforementioned, etc.

2. Description of the Related Art

Generally, a developer carrier is used in an image forming apparatus, such as a copy machine, a printer, a facsimile, a multifunction peripheral, etc., to develop a latent image formed on a photoconductor, which is a latent image bearer. The developer carrier is arranged at a position facing the photoconductor so as to develop the latent image on the photoconductor by carrying the developer stored in a developer accommodating container and conveying the developer to a developing position.

Conventionally, there are suggested various structures to remove a developer that remains on the photoconductor when an operation of a developing unit is stopped during a developing operation in such an image forming apparatus. For example, Japanese Laid-Open Patent Application No. 2001-209277 suggests a structure of collecting a developer remaining on a photoconductor by a developer carrier after rotating the photoconductor to convey the developer to the position at which the developer carrier is arranged while changing the electrostatic characteristic of the developer remaining on the photoconductor.

However, if the photoconductor is driven and rotated to remove the remaining developer, there may occur a rotation abnormality of the photoconductor due to locking of a photoconductor drive motor, which is caused by a load fluctuation generated by the remaining developer.

Thus, it is desirous to suppress the occurrence of the rotation abnormality of the photoconductor during the removing operation of removing the developer remaining on the photoconductor, which condition is caused by a stopping operation during a developing operation, when performing a subsequent startup operation.

SUMMARY OF THE INVENTION

There is provided according to an aspect of the present invention an image forming apparatus including a latent image bearer that carries a latent image and a developer carrier including a developer carrying member that carries a developer on a surface thereof. The developer carrier conveys the developer to a developing position opposite to the latent image bearer by moving the developer carrying member so as to develop the latent image carried by the latent image bearer. In a startup operation after a stop operation performed during a developing operation by the developer carrier, the developer carrying member is rotated for a predetermined time while said latent image bearer is set in a stopped state before starting a rotation.

There is provided according to another aspect of the present invention an image forming apparatus including a latent image bearer that carries a latent image and a developer carrier including a developer carrying member that carries a developer on a surface thereof. The developer carrying member of the developer carrier is rotated to convey the developer to a developing position opposite to the latent image bearer so as to develop the latent image carried by the latent image bearer. In a startup operation of the image forming apparatus after a stop operation, the developer carrying member is rotated for a predetermined time while the latent image bearer is set in a stopped state before starting a rotation.

There is provided according to a further aspect of the present invention an image forming method performed by an image forming apparatus including a latent image bearer that carries a latent image and a developer carrier including a developer carrying member that carries a developer on a surface thereof. The image forming method includes: in a startup operation of said image forming apparatus, determining whether an immediately preceding stop operation of said image forming apparatus is a normal stop or an abnormal stop; when the immediately preceding stop operation is the abnormal stop, rotating the developer carrying member for a first predetermined time while the latent image bearer is set in a stopped state before starting a rotation; after the first predetermined time has passed, rotating the latent image bearer and charging a surface of the latent image for a second predetermined time; and after the second predetermined time has passed, rotating the latent image bearer; conveying the developer carried by the developer carrying member to a developing position opposite to the latent image bearer by moving the developer carrying member; and developing the latent image carried by the latent image bearer by the developer conveyed by the developer carrying member at the developing position.

Other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings.

The objects and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and not restrictive of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a hardware structure of an image forming apparatus according to an embodiment;

FIG. **2** is an illustration of a plotter hardware part;

FIG. **3** is an enlarged cross-sectional view of a developing device;

FIGS. **4**A and **4**B are illustrations illustrating potential relationships between a photoconductor and a developing sleeve at a developing position;

FIG. **5** is an illustration of a developer for explaining an event that occurs when an abnormal stop is performed;

FIG. **6** is a block diagram of a startup operation controlling part;

FIG. **7** is a time chart illustrating an operation timing of each part during a startup operation performed by a printer;

FIG. **8** is a time chart illustrating an operation timing of each part during a startup operation performed by the image forming apparatus according to the embodiment;

FIG. **9** is an illustration of a developer for explaining an event that occurs during a startup operation after an abnormal stop;

FIGS. **10**A and **10**B are illustrations illustrating potential relationships between the photoconductor and the developing sleeve at a developing position after a long time has passed from an abnormal stop;

FIG. **11** is a flowchart of a startup operation controlled by a startup operation controlling part; and

FIG. **12** is a flowchart of another startup operation controlled by the startup operation controlling part.

DETAILED DESCRIPTION OF THE EMBODIMENTS

A description will now be given, with reference to the drawings, of embodiments of the present invention. In the embodiments described below, it is assumed that the "abnormal stop" designates i) a stop due to an activation of an emergency stop control during a developing operation in an image forming apparatus, ii) a stop due to a power OFF of an image forming apparatus during a developing operation, etc. The emergency stop control is performed when it is determined that the image forming apparatus is set in an abnormal state during a developing operation, which may lead to a malfunction, such as, for example, a case where an opening/closing door is open during a developing operation. As a case where a power of the image forming apparatus is turned OFF during a developing operation, there may be a power failure, an interruption of a power supply breaker, an erroneous operation of a power supply switch by a user, etc.

<1. Hardware Structure of Image Forming Apparatus>

First, a description is given of a hardware structure of an image forming apparatus according to an embodiment. FIG. **1** is a block diagram of a hardware structure of an electrophotographic printer **100** (hereinafter, simply referred to as the "printer"), which is an example of the image forming apparatus according to the present embodiment.

As illustrated in FIG. **1**, the printer **100** includes a CPU (computer) **111**, ROM **112**, RAM **113** and storage device **114** such as an HDD (Hard Disk Drive) or the like. The printer **100** further includes an engine part, operating part **116** and communication I/F part **117**. These elements constituting the printer **100** are mutually connected through a bus **118**.

The CPU **111** controls the entire printer **100** by executing various programs recorded in the ROM **112** or the storage device **114** using the RAM **113** as a work area. The CPU **111** also materializes various functions including a startup operation control function mentioned later.

The storage device **114**, which is a non-volatile storage medium, records programs executed by the CPU **111** and various kinds of data. The programs recorded in the storage device **114** include a program executed by the CPU **111** to materialize the startup operation controlling part **130** that provides a startup operation control function mentioned later.

The engine part **115** is provided with hardware (a plotter hardware part **140**) for materializing a printing function. Details of the plotter hardware part **140** will be mentioned later with reference to FIG. **2**.

The operating part **116** is used when a user performs various operations, such as inputting various settings to cause the printer **100** to perform a printing function and inputting an instruction to cause the printer **100** to perform a printing function. The communication I/F **117** is an interface for communication with an external device (not illustrated in the figure).

<2. Outline Structure of Plotter Hardware>

A description is given below of an outline structure of the plotter hardware part **140** that constitutes the printer **100**. FIG. **2** is an illustration of a structure of the plotter hardware part **140**.

As illustrated in FIG. **2**, the plotter hardware part **140** includes four toner image forming parts **206**Y, **206**M, **206**C and **206**K to create toner images in yellow, magenta, cyan and black (hereinafter, represented by Y, M, C and K)

The toner image forming parts **206**Y, **206**M, **206**C and **206**K use a Y toner, an M toner, a C toner and a K toner, respectively, but they have the same structure except for the usage of the different color toners. Thus, a description is given below of only the toner image forming part **206**Y for creating a Y toner image as a representative of the four toner image forming parts **206**Y, **206**M, **206**C and **206**K.

The toner image forming part **206**Y includes a drum-shaped photoconductor **201**Y, which is a latent image bearer, a drum cleaning device **202**Y, a discharging device (not illustrated), a charging device **204**Y, a developing device **205**Y, and an exposure device **207**Y. The charging device **204**Y charges the entire surface of the photoconductor **201**Y at a uniform potential while the photoconductor **201**Y is driven by a driving means (not illustrated) to rotate in a counterclockwise direction in the figure.

The surface potential of the photoreceptor **201**Y charged by the charging device **204**Y is hereinafter indicated as V**0**. The photoconductor **201**Y carries an electrostatic latent image for Y by being scan-exposed by a laser light emitted by the exposure device **20**. The surface potential of the electrostatic latent image portion of the photoconductor **201**Y, which is scan-exposed by the laser light, is hereinafter indicated as V**1**. The electrostatic latent image for Y is developed to be a Y toner image by the developing device **205**Y provided with the Y toner. Then, the Y toner image is transferred onto an intermediate transfer belt, which is an intermediate transfer member.

The drum cleaning device **202**Y performs cleaning to remove the toner remaining on the surface of the photoconductor **201**Y after being subjected to an intermediate transfer process. The discharging device discharges the residual electric charge of the photoconductor **201**Y after the cleaning by the drum cleaning device **202**Y. According to the discharging by the discharging device, the surface of the photoconductor **201**Y is initialized to be prepared for a subsequent image forming operation.

Similarly in other toner image forming parts **206**M, **206**C and **206**K, an M toner image, C toner image and K toner image are formed on the photoconductors **201**M, **201**C and **201**K, and are transferred onto the intermediate transfer belt **208**.

The exposing device **207**Y, **207**M, **207**C and **207**K, which are latent image forming units, project laser lights, which are emitted based on image information, onto the respective photoconductors **201**Y, **201**M, **201**C and **201**K in the toner image forming parts **206**Y, **206**M, **206**C and **206**K so as to expose the photoconductors **201**Y, **201**M, **201**C and **201**K with the respective laser lights. According to the exposure, the electrostatic latent images for Y, M, C and K are formed on the respective photoconductors **201**Y, **201**M, **201**C and **201**K.

An intermediate transfer unit **215** is arranged underneath the toner image forming parts **206**Y, **206**M, **206**C and **206**K. The intermediate transfer unit **215** includes the intermediate transfer belt **208** is an endless belt that rotates to move the toner images transferred thereon. The intermediate transfer unit **215** further includes four primary transfer bias rollers **209**Y, **209**M, **209**C and **209**K, a cleaning device **210** and a secondary transfer backup roller **212**.

The intermediate transfer belt **208** rotates in a clockwise direction in the figure. The primary transfer bias rollers **209**Y, **209**M, **2090** and **209**K sandwich the intermediate transfer belt **208** with the respective photoconductors **201**Y, **201**M, **201**C and **201**K so as to form primary transfer nip portions, respectively. In the primary transfer nip portions, the primary transfer bias rollers **209**Y, **209**M, **209**C and **209**K apply a transfer bias, which is a reverse polarity (for example, a plus bias voltage), to the backside of the intermediate transfer belt **208** (the inner surface of the loop). All of the rollers excluding the primary transfer bias rollers **209**Y, **209**M, **209**C and **209**K are electrically grounded.

In the process of sequentially passing through the primary transfer nip portions for Y, M, C and K with the rotation of the intermediate transfer belt **208**, the Y, M, C, and K toner images on the photoconductors **201**Y, **201**M, **201**C and **201**K are primarily transferred onto the intermediate transfer belt **208** in an overlapping manner. Thereby, a four color overlapping toner image (hereinafter, referred to as the "4-color toner image") is formed on the intermediate transfer belt **208**.

The secondary transfer backup roller **212** forms a secondary nip portion by sandwiching the intermediate transfer belt with a secondary transfer roller **219**. The 4-color toner image formed on the intermediate transfer belt **208** is transferred onto a transfer paper P at the secondary nip portion.

A reflection type photosensor **240** is arranged to oppose to the intermediate transfer belt **208** in an area between the lowermost toner image forming part **206**K and the secondary transfer nip portion so that the photosensor **240** outputs a signal corresponding to a reflectance of the surface of the intermediate transfer belt **208**. Specifically, the photosensor **240** includes reflection-type photosensors for each color Y, M, C and K that are arranged in a line in a direction of depth in FIG. **2** so as to individually detect an image density of each color in the 4-color toner image.

A remaining toner, which has not been transferred to the transfer paper P, adheres to the intermediate transfer belt **208** after passing through the secondary transfer nip portion. The transfer remaining toner is removed from the intermediate transfer belt **208** by the cleaning device **210**. In the secondary transfer nip portion, the transfer paper P is conveyed by being sandwiched between the intermediate transfer belt **208** and the secondary transfer roller **219** each of which rotates in a normal direction. The 4-color toner image is transferred to the surface of the transfer paper P conveyed out of the secondary transfer nip portion. The 4-color toner image is fixed by heat and pressure when the transfer paper P passes through an area between rotating rollers of the fixing device **220**.

<3. Structure of Developing Device>

A description is given below of the details of the structure of the developing device **205**Y. FIG. **3** is an enlarged cross-sectional view of the developing device **205**Y. The developing device **205**Y includes a developing roller **301**Y. A part of the circumferential surface of the developing roller **301**Y is exposed outside through an opening part provided in a casing **310**Y.

The developing roller **301**Y, which is a developer carrying roller, includes a developing sleeve **311**Y (developer carrying member) and a magnet roller **312**Y. The developing sleeve **311**Y is made of a non-magnetic pipe, and is rotatable by a driving means (not illustrated in the figure). The magnet roller **312**Y is encircled by the developing sleeve **311**Y, and does not rotate together with the rotation of the developing sleeve **311**Y.

A certain amount of Y developer (not illustrated in the figure) is stored in the developing device. **205**Y. The Y developer contains a magnetic carrier and a Y toner having a minus charging property.

The Y developer is agitated and conveyed by two conveyance screws **304**Y and **305**Y. Thereby, the Y toner contained in the Y developer is frictionally charged. Then, the Y developer is attached to the surface of the rotating developing sleeve **311**Y by the magnetic force of the magnet roller **312**, which is a magnetic field generating means in the developing sleeve **301**Y, and is conveyed by the developing sleeve **311**Y.

The Y developer is conveyed with a rotation of the developing sleeve **311**Y and passes through a position opposite to a developing doctor **30**, which is a restricting member. The thickness of the Y developer is restricted by the developing doctor **30**, and, then, the Y developer is conveyed to a developing position opposite to the photoconductor **201**Y.

In the developing position, between the developing sleeve **311**Y to which the developing bias of a negative polarity is applied and the electrostatic latent image portion (surface potential=V**1**) on the photoconductor **201**Y, a developing potential is applied to the Y toner to electrostatically move the Y toner having a negative polarity from the side of the developing sleeve **311**Y to the side of the electrostatic latent image. Additionally, between the developing sleeve **311**Y and the uniformly charged portion (surface portion (surface potential=V**0**)) on the photoconductor **201**Y, a non-developing potential is applied to the Y toner to electrostatically move the Y toner having a negative polarity from the side of the surface portion to the side of the developing sleeve **311**Y. It is assumed that the developing bias Vb having a negative polarity is supplied to from a power supply source (not illustrated in the figure).

The Y toner contained in the Y developer on the developing sleeve **311**Y is separated from the developing sleeve **311**Y due to an action of the developing potential, and is transferred to the electrostatic latent image portion of the photoconductor **201**Y. According to the transfer, the latent image on the photoconductor **201**Y is developed and changed into a Y toner image. The Y developer of which the Y toner is consumed by the development is returned to the interior of the casing **310**Y with the rotation of the development sleeve **311**Y.

As illustrated in FIG. **2**, the developing device **205**Y has a toner density sensor **230**Y, which is constituted by a magnetic permeability sensor. The toner density sensor **230**Y outputs a voltage corresponding to the magnetic permeability of the Y developer stored in the developing device **205**Y. Because the magnetic permeability of the developer exhibits an excellent collation with the toner density of the developer, the toner density sensor **230**Y outputs a voltage corresponding to the toner density. The value of the output voltage is sent to a toner supply controlling part (not illustrated in the figure).

The toner supply controlling part includes a storage unit, such as a RAM, in which a target value (Vtref for Y) of the voltage output from the toner density sensor for Y is stored. The storage unit also stores data of Vtref for M, C and K, which represent target values of voltages output from the toner density sensors mounted on other developing devices.

In the developing device **205**Y, the value of the voltage output from the toner density sensor **230**Y is compared with Vtref, which is a target vale of the output voltage for Y so as to cause the Y toner density supply device (not illustrated in the figure) to drive for a time corresponding to a result of the comparison. Thereby, the replenishing Y toner can be supplied to the developing device **205**.

Accordingly, by the control of the drive of the Y toner density supply device, an appropriate amount of the Y toner is supplied to the Y developer of which the Y toner density is decreased with the developing operation. Thus, the density of Y toner contained in the Y developer stored in the developing device **205**Y can be maintained within a predetermined range. For example, the toner density is maintained within a range from 5 weight % to 9 weight % in a developer that is a combination of a toner having a particle diameter of 6 μm and a carrier having a particle diameter of 35 μm.

<4. Event Occurring at Developing Position at Abnormal Stop Time>

A description is given below of an event which occurs at the developing position when an operation of the printer **100** having the above-mentioned structure is stopped due to an abnormality (hereinafter, referred to as the “abnormal stop”). In a state where a developing operation is carried out normally, at the developing position, the surface potential V**0** of the uniformly charged portion (surface portion) of the photoconductor **201**Y, the developing bias Vb having a negative polarity and the surface potential V**1** of the electrostatic latent image portion have a relationship as illustrated in FIG. **4**A.

On the other hand, if an operation of the printer **100** is stopped due to an abnormality and a power supply is interrupted, the developing bias Vb drops to the ground potential because a power supply to a power board, which has applied the developing bias, is interrupted. On the other hand, the surface potential V**0** of the uniformly charged portion (surface portion) and the surface potential V**1** of the electrostatic latent image portion on the photoconductor **201**Y are almost unchanged and maintained at the values before the abnormal stop. As a result, the relationship in potential between the photoconductor **201**Y and the developing sleeve **311**Y at the developing position in the case of the abnormal stop is as illustrated in FIG. **4**B.

In the state illustrated in FIG. **4**B, an extremely large electric field is generated between the developing sleeve **311**Y, which has become a ground potential, and the uniformly charged portion (surface potential=V**0**) of the photoconductor **201**Y to move the carrier having a positive polarity from the developing sleeve **311**Y to the surface side of the photoconductor **201**.

Here, at the time of the abnormal stop, the power supply to a drive motor, which is a driving unit to rotate the photoconductor **201**Y and the developing sleeve **311**Y, and the power supply to the power board, which has supplied the developing bias Vb, are interrupted almost simultaneously. On the other hand, after the developing bias Vb dropped to the ground potential and the condition of the potentials is set to the relationship illustrated in FIG. **4**B, the photoconductor **201**Y and the developing sleeve **311**Y continue to rotate due to an inertial force for a time of about several hundred milliseconds.

At this time, because the extremely large electric field is generated at the developing position to move the carrier having a positive polarity from the developing sleeve **311**Y to the surface side of the photoconductor **201**Y, an adhesion of the carrier to the photoconductor **201** occurs. As a result, as illustrated in FIG. **5**, a developer pool **500**Y in which the developer is accumulated is formed on an upstream side of the developing position.

Note that an amount of the developer pool **500**Y becomes larger as the potential of the uniformly charged portion (surface portion (surface potential=V**0**)) of the photoconductor **201**Y is higher (larger) because the intensity of the electric field that electrostatically moves the carrier having a positive polarity from the developing sleeve **311**Y to the surface side of the photoconductor **201**Y is increased.

<5. Functional Structure of Startup Operation Controlling Function>

A description is given below of a functional structure of the startup operation controlling part **130** in the printer **100**, which suppresses an occurrence of a rotation abnormality of the photoconductor **201**Y while removing the above-mentioned developer pool **500**Y. FIG. **6** is a block diagram illustrating a functional structure of the startup operation controlling part **130** in the printer **100**.

As illustrated in FIG. **6**, the startup operation controlling part **130** includes a detecting part **600**, a photoconductor drive motor controlling part **601**, a charging device controlling part **602**, a developing roller drive motor controlling part **603** and a developing bias controlling part **604**.

The detecting part **600** determines whether an immediately preceding stop operation was “normal stop” or “abnormal stop”. Specifically, the detecting part **600** sets a flag during the developing operation and resets the flag after ending the developing operation. The detecting part **600** refers to the flag when performing a startup operation after a stop operation to determine whether the stop was “normal stop” or “abnormal stop”. A result of the comparison is sent to the photoconductor drive motor controlling part **601**, the charging device controlling part **602**, the developing roller drive motor controlling part **603** and the developing bias controlling part **604**.

The photoconductor drive motor controlling part **601** controls a photoconductor drive motor (not illustrated in the figure), which is a drive unit of rotating the photoconductor **201**Y, to drive/stop.

The charging device controlling part **602** controls a charging operation to the photoconductor **201**Y by the charging device **104** to start/end. Note that the photoconductor derive motor controlling part **601** and the charging device controlling part **602** are configured to operate in synchronization with each other. Additionally, each of the photoconductor drive motor controlling part **601** and developing roller drive motor controlling part **603** is configured to operate in response to an operating condition of the other.

<6. Startup Operation After Abnormal Stop>

A description will be given of a startup operation performed by the startup operation controlling part **130** of the printer **100** after an abnormal stop. First, as a target for comparison, a description is given of a typical startup operation performed in a popular printer.

<6.1 Startup Operation After Abnormal Stop in General Printer>

FIG. **7** is a time chart indicating operation timings of a photoconductor, charging device, developing sleeve and developing bias in a startup operation after an abnormal stop in a general printer. As illustrated in FIG. **7**, in the startup operation after an abnormal stop in a popular printer, the photoconductor and the charging device start operations first, and, then, a rotation of the developing sleeve and an application of the developing bias are started after a fixed time period (section **701**) has passed.

In this case, there is no change in the developer pool **500**Y on the upstream side of the developing position, which is formed due to the abnormal stop during the section **701** where the photoconductor rotates first in the state where the developing sleeve is stopped.

Thereafter, when the rotation of the development sleeve is started (in section **702** in FIG. **7**), the developer accumulated in the developer pool **500**Y is pressed into the developing position all at once. As a result, a load fluctuation is generated, which causes the photoconductor drive motor to lock, and, thereby, a rotation abnormality of the photoconductor occurs.

Especially, if a stepping motor is used as the photoconductor drive motor, which is a drive unit for driving the photoconductor, the locking of the photoconductor drive motor occurs more easily when the developer accumulated in the developer pool **500**Y is pressed into the developing position all at once and a load fluctuation is generated.

<6.2 Startup Operation After Abnormal Stop in Printer **100**>

A description is given below of a startup operation after an abnormal stop performed by the startup operation controlling part **130** of the printer **100** after according to the present embodiment. In the printer according to the present embodiment, if the detecting part **600** determines that an immediately preceding stop operation is the "abnormal stop", a startup operation different from the above-mentioned startup operation after an abnormal stop in the popular printer is performed in order to suppress an occurrence of a rotation abnormality of the photoconductor **201**Y.

FIG. **8** is a time chart indicating operation timings of the photoconductor **201**Y, charging device **204**Y, developing sleeve **311**Y and developing bias in the startup operation after an abnormal stop performed by the startup operation controlling part **130** of the printer according to the present embodiment. As illustrated in FIG. **8**, in the printer according to the present embodiment, the developing sleeve **311** is rotated for a predetermined time period (section **803**) in a stopped state before the rotation of the photoconductor **201**Y and the charging by the charging device **204** are started. Additionally, the developing bias is applied to the developing sleeve **311**Y for the predetermined time period (section **803**).

If the developing sleeve **311**Y is rotated in a state where the photoconductor **201**Y is stopped, the developer accumulated in the developer pool **500**Y flows and passes through the developing position (the closest point between the developing sleeve and the photoconductor). Thereby, the amount of the developer in the developer pool **500**Y is reduced. In this circumstance, because the photoconductor **201**Y is not rotated yet, there is no possibility that the photoconductor drive motor locks due to a load fluctuation.

Here, in order to reduce the developer in the developer pool **500**Y to the extent that the photoconductor drive motor does not lock when the photoconductor drive motor is driven in the section **701**, it is necessary to rotate the developing sleeve **311**Y by more than a fixed angle (for example, a half rotation) to carry the developer in the developer pool **500**Y to a downstream side.

Although the time period (section **803**) for rotating the developing sleeve **311**Y by more than the fixed angle depends on the characteristic of the developer and the photoconductor drive motor, an environment, etc., the section **803** is preferably about 20 milliseconds to about 1 second. Note that an upper limit is set to the time of rotation of the developing sleeve **311**Y because there is a possibility of generating an uneven wear of the photoconductor **201**Y due to local abrasion of the photoconductor **201**Y if the developing sleeve **311**Y is rotated for a long time in a state where the photoconductor **201**Y is stopped. Additionally, it is not desirable from the viewpoint of user convenience to spent a long time in the startup operation due to the rotation of the developing sleeve **311**Y.

Note that if the process speed (a linear velocity of the photoconductor surface) of the printer **100** is set to 440 mm/s, the diameter of the development sleeve **311**Y is set to 30 mm, and the development linear velocity ratio is set to 1.5, a time required by the developing sleeve **311**Y to rotate a half rotation is about 71 milliseconds. If such a time period is taken, it can contribute to the prevention of locking of the photoconductor drive motor to that extent of a range almost the same as the time required by the startup operation after an abnormal stop in the above-mentioned popular printer.

Note that the amount of the developer in the developer pool **500**Y may be grasped previously so as to calculate a time period required for reducing the amount of developer to the extent that the photoconductor drive motor does not lock. The thus-calculated time period is stored in a memory of the printer **100**, and the section **803** may be determined based on the stored time period.

<6.3 Reason for Applying Developing Bias in Startup Operation After Abnormal Stop in Printer **100**>

As mentioned above, in the printer **100** according to the present embodiment, the developing sleeve **311**Y is rotated for the predetermined time (section **803**) and a developing bias is applied during the startup operation after an abnormal stop in the state where the photoconductor **201** is stopped. However, the photoconductor drive motor can be prevented from being locked by merely rotating the developing sleeve **311**Y without applying a developing bias. The reason for applying a developing bias in synchronization with the rotation of the developing sleeve **311** is mentioned below.

Because the dark attenuation speed of the photoconductor **201**Y is slow, it takes a considerably long time (several minutes to several ten minutes) until the surface potentials V**0** and V**1** fall below the developing bias Vb. Thus, the surface potential V**0** of the uniformly charged portion (surface portion) and the surface potential V**1** of the electrostatic latent image portion of the photoconductor **201**Y are almost unchanged from the state at the time of abnormal stop in the printer **100**.

Accordingly, if the developing sleeve **311**Y is rotated without applying a developing bias in the section **803**, similar to the time of an abnormality stop, an extremely large electric field is generated, which electrostatically moves the carrier having a positive polarity from the developing sleeve **311**Y to the photoconductor **201**Y. As a result, an amount of the developer flowing through the developing position (closest position between the developing sleeve and the photoconductor) becomes small and, thereby, the amount of the developer stored in the developer pool **500**Y hardly reduces. Additionally, because the carrier adheres to the surface of the photoconductor **201**Y, if the photoconductor **201**Y is rotated in the section **701**, the carrier adhering to the surface of the photoconductor **201** is input into a drum cleaning device **202**Y and a cleaning device **210** in a subsequent stage. As a result, there may be a problem of an occurrence of an adverse reaction that the photoconductor **201**Y and the intermediate transfer belt **208** are damaged.

On the other hand, if a developing bias is applied in synchronization with the rotation of the developing sleeve **311**Y in the section **803**, the photoconductor drive motor can be reliably prevented from being locked, and also such an adverse reaction can be prevented from being occurred.

An advantage of applying a developing bias in synchronization with the rotation of the developing sleeve **311**Y in the section **803** can be acquired even in a case where a considerable time has passed after an abnormal stop of the printer **100** and until a startup operation is performed.

If a considerable time has passed after an abnormal stop of the printer **100** and until a startup operation is performed, the surface potential of the photoconductor **201** may be dark-attenuated (refer to an arrow **1000** indicated between FIGS. **10**A and **10**B), and the surface potential falls below the developing bias Vb. In this condition, an electric field, which causes the Y toner having a negative polarity to move from the side of the developing sleeve **311**Y to the side of the electrostatic latent image, is generated in an area between the developing sleeve **311**Y and the electrostatic latent image portion (surface potential=V**1**) on the photoconductor **201**Y. Thus, the Y toner having a negative polarity merely adheres to the surface of the photoconductor **201**Y, and the above-mentioned adverse reaction does not occur.

As mentioned above, it is more desirable to apply a development bias in synchronization with the rotation of the developing sleeve **311**Y in the startup operation after an abnormal stop.

<7. Flow of Startup Operation by Startup Operation Controlling Part>

A description will be given of a flow of a startup operation performed by the startup operation controlling part **130**. FIG. **11** is a flowchart illustrating a flow of a basic startup operation performed by the startup operation controlling part **130**.

First, in step S**1102**, the development roller drive motor controlling part **603** sends an instruction to drive the developing roller drive motor to rotate the developing sleeve **311**Y. Additionally, the developing bias controlling part **604** sends an instruction to apply a developing bias to the developing sleeve **311**Y.

In step S**1103**, the startup operation controlling part **130** determines whether a predetermined time (section **803**) has passed after the instruction of driving the development roller drive motor and the instruction of applying a developing bias were sent. If it is determined in step S**1103** that the predetermined time (section **803**) has not passed yet, the startup operation controlling part **130** waits for passage of the predetermined time (section **803**).

On the other hand, if it is determined in step S**1103** that the predetermined time (section **803**) has passed, the startup operation controlling part **130** proceeds to step S**1104**. In step S**1104**, the developing roller drive motor controlling part **603** sends an instruction to stop the developing roller drive motor to stop the rotation of the developing sleeve **311**Y. Additionally, the developing bias controlling part **604** sends an instruction to end the application of the developing bias to the developing sleeve **311**Y.

Then, in step S**1105**, the photoconductor drive motor controlling part **601** sends an instruction to drive the photoconductor drive motor to rotate the photoconductor **201**Y. Additionally, the charging device controlling part **602** sends an instruction to start charging by the charging device **204**Y.

Then, in step S**1106**, the startup operation controlling part **103** determines whether a predetermined time (section **701**) has passed after the instruction of driving the photoconductor drive motor and the instruction of starting the charging were sent. If it is determined in step S**1106** that the predetermined time (section **701**) has not passed yet, the startup operation controlling part **103** waits for passage of the predetermined time (section **701**).

On the other hand, if it is determined in step S**1106** that the predetermined time (section **701**) has passed, the startup operation controlling part **130** proceeds to step S**1107**. In step S**1107**, the developing roller drive motor controlling part **603** sends an instruction to drive the developing roller drive motor to rotate the developing sleeve **311**Y. Additionally, the developing bias controlling part **604** sends an instruction to start applying a developing bias to the developing sleeve **311**Y. Thereby, the startup operation after an abnormal stop is completed.

A description is given below, with reference to another example of the startup operation. FIG. **12** is a flowchart of another example of the startup operation performed by the startup operation controlling part **130**. The startup operation illustrated in FIG. **12** is the same as the startup operation illustrated in FIG. **11** except for a determining process performed by the detecting part **600**, and duplicate descriptions of the steps will be omitted.

In the startup operation illustrated in FIG. **12**, the process of step S**1101** is first performed by the detecting part **600** of the startup operation controlling part **130**. That is, in step S**1101**, the detecting part **600** determines whether the immediately preceding stop operation is a normal stop or an abnormal operation. If the detecting part **600** determines in step S**1101** that the immediately preceding step is an abnormal stop, the process proceeds to step S**1102** to perform the above-mentioned startup operation explained with reference to FIG. **11**. Thereby, the startup operation after an abnormal stop is completed.

On the other hand, if the detecting part **600** determines in step S**1101** that the immediately preceding stop operation is a normal stop, the process proceeds to step S**1105** without performing the process of steps S**1102** through S**1104** to perform the above-mentioned process of steps S**1105** through S**1107**. Thereby, the startup operation after a normal stop is completed.

<8. Summary>

As mentioned above, in the printer **100** according to the present embodiment, the developing sleeve is rotated for the predetermined time in the stopped state before the rotation of the photoconductor is started, and a developing bias is applied in synchronization with the rotation of the developing sleeve for the predetermined time.

That is, the image forming apparatus according to the present embodiment rotates the developing sleeve and applies a developing bias for the predetermined time in the state where the photoconductor is stopped. Accordingly, an amount of the developer in the developer pool created due to an abnormal stop can be reduced before the rotation of the photoconductor is started.

As a result, it becomes possible to avoid an occurrence of a rotation abnormality of the photoconductor due to a load fluctuation caused by a remaining developer when the photoconductor is started to rotate in the startup operation after an abnormal stop.

In the present embodiment, a DC motor or a stepping motor can be used as the photoconductor drive motor, which is a drive unit for rotating the photoconductor **201**Y. However, as mentioned above, the stepping motor has a characteristic of being more easily locked than the DC motor when a load fluctuation occurs due to the developer accumulated in the developer pool **500**Y being pushed into the developing position (the closest position between the developing sleeve and the photoconductor) all at once. Thus, the present embodiment is especially effective to the case where a stepping motor is used as the photoconductor drive motor, which is a drive unit for rotating the photoconductor **201**Y.

Moreover, according to startup operation illustrated in FIG. **12**, different startup operations are performed depending on whether the immediately preceding stop operation is a normal stop or an abnormal stop. However, the startup operation is not limited to such operations, and the startup operation after a normal stop may be the same as the startup operation after an abnormal stop.

However, if the developing sleeve **311**Y is rotated in the state where the photoconductor **201**Y is stopped, a specific portion of the photoconductor **201**Y is scrubbed by the developer even though it is in an extremely short time. Thus, it is desirous to perform the startup operation illustrated in FIG. **8** only after an abnormal stop.

All examples and conditional language provided herein are intended for pedagogical purposes of aiding the reader in understanding the invention and the concepts contributed by the inventors to further the art, and are not to be construed as limitations to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority or inferiority of the invention. Although one or more embodiments of the present invention have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. An image forming apparatus, comprising:

a latent image bearer that carries a latent image; and

a developer carrier including a developer carrying member that carries a developer on a surface thereof, the developer carrier conveying the developer to a developing position opposite to said latent image bearer by moving said developer carrying member so as to develop the latent image carried by the latent image bearer,

wherein in a startup operation that is performed after a determination that a stop operation performed during a developing operation by said developer carrier was caused by an abnormality, said developer carrying member is rotated for a first predetermined time while said latent image bearer is set in a stopped state before starting a rotation; and

wherein after the rotation of the developer carrying member has stopped for another predetermined time while the latent image bearer is rotated, the developer carrying member is rotated a second time while the latent image bearer continues to rotate.

2. The image forming apparatus as claimed in claim **1**, wherein a developing bias is applied to said developer carrying member in synchronization with the rotation of said developer carrying member for the first predetermined time.

3. The image forming apparatus as claimed in claim **1**, wherein said developer carrying member is rotated at least a half rotation while said latent image bearer is set in the stopped state before starting a rotation.

4. An image forming apparatus, comprising:

a latent image bearer that carries a latent image; and

a developer carrier including a developer carrying member that carries a developer on a surface thereof, the developer carrier conveying the developer to a developing position opposite to said latent image bearer by moving said developer carrying member so as to develop the latent image carried by the latent image bearer,

wherein in a removal operation of said image forming apparatus after a stop operation, said removal operation to remove remaining developer that remains on the latent image bearer after the stop operation, said remaining developer remaining on the latent image bearer above a closest point between the latent image bearer and the developer carrying member, said developer carrying member is rotated for a predetermined time while said latent image bearer is set in a stopped state before starting a rotation, so as to cause the remaining developer to pass through the closest point between the latent image bearer and the developer carrying member.

5. The image forming apparatus as claimed in claim **4**, wherein a developing bias is applied to said developer carrying member in synchronization with the rotation of said developer carrying member for the predetermined time.

6. The image forming apparatus as claimed in claim **4**, wherein said developer carrying member is rotated at least a half rotation while said latent image bearer is set in the stopped state before starting a rotation.

7. An image forming method performed by an image forming apparatus including a latent image bearer that carries a latent image and a developer carrier including a developer carrying member that carries a developer on a surface thereof, the image forming method comprising:

performing a startup operation after a determination that a stop operation performed during a developing operation by said developer carrier was caused by an abnormality, wherein in said startup operation said developer carrying member is rotated for a first predetermined time while said latent image bearer is set in a stopped state before starting a rotation; and

rotating, after the rotation of the developer carrying member has stopped for another predetermined time while the latent image bearer is rotated, the developer carrying member a second time while the latent image bearer continues to rotate, and

conveying the developer carried by said developer carrying member to a developing position opposite to said latent image bearer by moving said developer carrying member.

8. The image forming method as claimed in claim **7**, further comprising applying a developing bias in synchronization with the rotating said developer carrying member for the first predetermined time.

9. The image forming method as claimed in claim **7**, wherein said developer carrying member rotates by at least a half rotation when rotating said developer carrying member for the first predetermined time while said latent image bearer is set in the stopped state before starting a rotation.

10. The image forming apparatus as claimed in claim **2**, wherein after the bias has stopped being applied to the developing carrying member, a developing bias is applied to the developer carrying member a second time.

11. The image forming apparatus as claimed in claim **1**, wherein a surface of the latent image bearer is charged while the developer carrying member is rotated the second time while the latent image bearer continues to rotate.

12. The image forming apparatus as claimed in claim **10**, wherein a surface of the latent image bearer is charged while the developer carrying member is rotated the second time and the developing bias is applied to the developer carrying member the second time.

13. The image forming apparatus as claimed in claim **1**, wherein the first predetermined time period is determined based on an amount of pooled developer.

14. The image forming apparatus as claimed in claim **1**, further comprising a stepping motor for rotating the latent image bearer.

15. The image forming apparatus as claimed in claim **1**, wherein the startup operation is performed only after a determination that a stop operation performed during the developing operation by the developer carrier was caused by an abnormality.

16. An image forming apparatus, comprising:

a latent image bearer that carries a latent image; and

a developer carrier including a developer carrying member that carries a developer on a surface thereof, the developer carrier conveying the developer to a developing position opposite to said latent image bearer by moving said developer carrying member so as to develop the latent image carried by the latent image bearer, the developer carrier and the latent image bearer being rotated from upward to a facing region at which the developer carrier and the latent image bearer face each other,

wherein in a removal operation of said image forming apparatus after a stop operation, said developer carrying member is rotated from upward to the facing region for a first predetermined time while said latent image bearer is set in a stopped state before starting a rotation; and

wherein after the rotation of the developer carrying member has stopped for another predetermined time while the latent image bearer is rotated, the developer carrying member is rotated a second time while the latent image bearer continues to rotate.

17. The image forming apparatus as claimed in claim **16**, wherein said removal operation is an operation to remove developer that remains upward of the region after the stop operation.

18. The image forming apparatus as claimed in claim **16**, wherein a developing bias is applied to said developer carrying member in synchronization with the rotation of said developer carrying member for the first predetermined time.

19. The image forming apparatus as claimed in claim **16**, wherein said developer carrying member is rotated at least a half rotation while said latent image bearer is set in the stopped state before starting a rotation.

20. The image forming apparatus as claimed in claim **16**, wherein the first predetermined time period is determined based on an amount of pooled developer.

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